

structure on a substrate, the multi-layer structure including the photoresist pattern, one layer of the multi-layer structure having fluorescence; and inspecting the photoresist pattern using a fluorescence microscope.

[0024] In example embodiments, the fluorescence microscope may be configured to use at least one of a reversible saturable optical fluorescence transitions (RESOLFT) or a stochastic functional technique.

[0025] In example embodiments, the photoresist pattern may include at least one fluorescent additive, the at least one fluorescent additive includes a first fluorescent additive and a second fluorescent additive that have different colors from each other, and the one layer of the multi-layer structure having fluorescence may be the photoresist pattern.

[0026] In example embodiments, the forming the multi-layer structure may include forming an anti-reflective layer on the substrate and forming the photoresist pattern on the anti-reflective layer, and the one layer of the multi-layer structure having fluorescence may be the anti-reflective layer.

[0027] In example embodiments, the one layer of the multi-layer structure may have fluorescence in the photoresist pattern; and the forming the multi-layer structures includes, forming a photoresist layer on the substrate, performing a preliminary photolithography process on the photoresist layer to form a preliminary photoresist pattern, and injecting a conditional fluorescent material into the preliminary photoresist pattern, the conditional fluorescent material having a property showing fluorescence under an acid condition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The foregoing and other features of inventive concepts will become more apparent from the more particular description of non-limiting embodiments of inventive concepts, as illustrated in the accompanying drawings in which like reference characters refer to like parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating principles of inventive concepts. In the drawings:

[0029] FIG. 1 is a flow chart illustrating a method for inspecting and/or observing a photoresist pattern, according to example embodiments of inventive concepts.

[0030] FIGS. 2A and 2B are cross-sectional views illustrating the method for inspecting and/or observing a photoresist pattern of FIG. 1.

[0031] FIG. 3 schematically illustrates a planar image of a structure of FIG. 2B or 5C obtained using a fluorescence microscope.

[0032] FIG. 4 is a flow chart illustrating a method for inspecting and/or observing a photoresist pattern, according to example embodiments of inventive concepts.

[0033] FIGS. 5A to 5C are cross-sectional views illustrating the method for inspecting and/or observing a photoresist pattern of FIG. 4.

[0034] FIG. 6 is a flow chart illustrating a method for inspecting and/or observing a photoresist pattern, according to example embodiments of inventive concepts.

[0035] FIG. 7 is a cross-sectional view illustrating the method for inspecting and/or observing a photoresist pattern of FIG. 6.

[0036] FIG. 8 schematically illustrates a planar image of a structure of FIG. 7 obtained using a fluorescence microscope.

[0037] FIG. 9 is a flow chart illustrating a method for inspecting and/or observing a photoresist pattern, according to example embodiments of inventive concepts.

[0038] FIGS. 10A and 10B are cross-sectional views illustrating the method for inspecting and/or observing a photoresist pattern of FIG. 9.

[0039] FIGS. 11 and 12 schematically illustrate planar images of a structure of FIG. 10B obtained using a fluorescence microscope, respectively.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0040] Inventive concepts will now be described more fully hereinafter with reference to the accompanying drawings, in which example embodiments of inventive concepts are shown. Inventive concepts and methods of achieving them will be apparent from the following example embodiments that will be described in more detail with reference to the accompanying drawings. Example embodiments of inventive concepts may, however, be embodied in many different forms and should not be constructed as being limited to the embodiments set forth herein. Rather, these example embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of example embodiments of inventive concept to those of ordinary skilled in the art.

[0041] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular terms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes” and/or “including,” if used herein, specify the presence of stated features, integers, steps, operations, elements and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components and/or groups thereof. Expressions such as “at least one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0042] It will be understood that when an element is referred to as being “connected” or “coupled” to another element, it may be directly connected or coupled to the other element or intervening elements may be present. Other words used to describe the relationship between elements or layers should be interpreted in a like fashion (e.g., “between” versus “directly between,” “adjacent” versus “directly adjacent,” “on” versus “directly on”).

[0043] It will be understood that, although the terms “first,” “second,” etc. may be used herein to describe various elements, components, regions, layers and/or sections. These elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of example embodiments.

[0044] Spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper” and the like, may be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s).